PHOTO BY BROOKE HILL, USGS

FIGURE 1. *A remotely triggered net set ready to capture a group of roosting black-necked stilts in a San Francisco Bay marsh.*

Science Feature

A Collaborative Project to Study Mercury Levels in San Francisco Bay Waterbirds

The San Francisco Bay has a legacy of mercury contamination from historical mercury mining in the Coast Range and gold extraction in the Sierra Nevada's. Because of this pollution, the Bay is listed as an impaired water body under the Clean Water Act and several human advisories for limits on fish consumption are currently in place by the State of California's Office of Environmental Health Hazard Assessment (http://www.oehha.ca.gov/fish/general/sfbaydelta.html).

Additionally, current restoration plans to convert salt evaporation ponds into tidal marsh could result in increased availability of methyl mercury, the most toxic and bioavailable form of mercury to humans and wildlife. The reproductive success of waterbirds breeding within the Bay may also be impaired by mercury contamination but few studies have examined its effects on avian reproduction within the estuary.

U.S. Fish and Wildlife Service, U.S. Geological Survey, San Francisco Bay Bird Observatory, and PRBO Conservation Science biologists are investigating the risks of mercury to waterbirds within the Bay in a large collaborative project funded by the CalFed Bay Delta Program. The project seeks to assess the dietary sources and current mercury concentrations in waterbirds and, ultimately, the effect of mercury exposure on avian reproduction.

This is a complex research project that examines many aspects of avian reproduction, beginning in the pre-breeding time period (February to April) when birds accumulate much of the mercury deposited into eggs and throughout the breeding and post-breeding seasons (April to August) when birds are actively nesting and chicks are growing to fledging.

PHOTO BY BROOKE HILL, USGS

FIGURE 2. *Biologists measure the bill length of a captured female Avocet.*

The project has many field components, including capturing and radio-marking birds to track habitat use, sampling bird blood and feathers for mercury concentrations, evaluating nesting success, and examining chick movements and survival. Although the study is just two years old, it has already produced several interesting findings. For example, mercury concentrations in breeding birds are higher in birds that eat fish, like terns, than in birds that eat mainly aquatic invertebrates, like avocets and stilts.

Further, mercury concentrations in birds breeding within the southern-most region of the San Francisco Bay (such as the Alviso salt pond complex of the Don Edwards San Francisco Bay National Wildlife Refuge) are higher than birds breeding in the south-central bay at Eden Landing Ecological Reserve or in the North Bay in the Napa-Sonoma Marsh Wildlife Area. These higher mercury levels in the southern San Francisco Bay are likely a consequence of highly contaminated sediments that have been transported through Alviso Slough, the discharge point for the Guadalupe River watershed which contains the historic New Almaden mercury mine. It is difficult to detect the effects of mercury on the

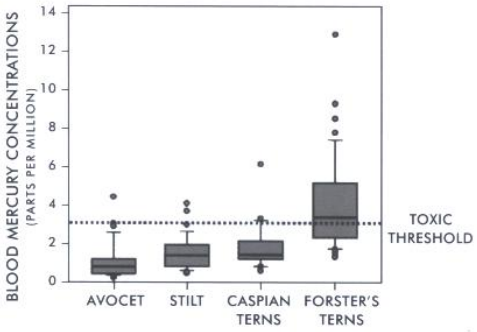

FIGURE 3. *Mercury concentrations in the blood of breeding waterbirds in the San Francisco Bay. Each species had individuals above the toxic threshold concentration of 3.0 parts per million, where effects of mercury on breeding birds has been observed in the wild. The box plots depict the range of the data, from the 25th percentile (lowest portion in color bar), median (center white line in color bar), and upper 75th percentile (upper portion in color bar). Bird samples were analyzed by the USGS Davis Field Station Mercury Lab.*

See videos of the camera nests online at www.sfbbo.org/baybirds_projects.html

A SCREENSHOT *from an American Avocet camera nest in the South Bay.*

reproduction of wild birds because of other stressors such as predation. Therefore, an additional component of the project is monitoring waterbird nest success to document effects of both mercury and predators. Included in this research was the use of remote infrared video cameras to determine the types of predators eating bird eggs (see Maliheh Nakhai's internship report for further explanation). The study documented gulls as voracious predators on waterbird nests and chicks, especially on avocet chicks that were particularly susceptible to aerial predation. If you click on the video links available from http://www.sfbbo.org/baybirds_projects.html, you can see the before and after pictures of an avocet nest being visited by a gull. In the first video, the avocet parent returns to the nest for an incubation shift whereas in the second video, a gull steals an egg from the avocet nest.

Scientists will continue to examine waterbird mercury burdens in the Bay. Our ultimate goal is to assess the impact of mercury contamination on waterbird reproduction and to be able to advise current restoration efforts to convert existing salt evaporation ponds back into tidal marsh. The project is now entering its final year and is sure to uncover more interesting results as data are more thoroughly analyzed.

By Dr. Josh Ackerman[1] and Collin Eagles-Smith[2]

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Field Log | Waterbird Extravaganza

PHOTO BY CHERYL STRONG

AS THE BIRD OBSERVATORY INTERN working on the mercury contamination study in 2006, I joined the research crew to capture, tag, and nest-monitor American Avocets, Black-necked Stilts, and Forster's Terns at study sites in and around Alviso, Fremont, and Vallejo.

ROCKET ORNITHOLOGY The field season began in late February, with pre-breeding "captures" of avocets and stilts. Each capture was done with box nets or net launchers—a net was put in place, attached to a number of rockets, and set off when birds were roosting close by.

Each net rocketed off was a gamble dependent on whether birds were lined up, whether they were within range of the net, and whether they were likely to get away while the net was still flying. When a capture finally happened, the crew would be adrenaline-charged from the anticipation and we would sprint out to the nets to extract the birds.

After the excitement of a successful capture, we happily buckled down to "process" the birds. Processing involved radio-tagging the birds and taking a small blood sample, as well as many other measurements. To tag the birds, we fitted a ring, to which a radio was attached, around the bird's upper leg and also placed a series of three color-bands and a numbered identification band on the opposite leg. Later, technicians tracked the movement of those birds using radio-telemetry as well as sight identification.

BIRDS, CAMERA, ACTION! Due to the excessive rains this year, breeding season for the stilts and avocets began in May. Assigned to an area to search for and monitor nests, I spent this time numbering each egg, determining its incubation stage, and tracking the progress of each nest.

Most intriguing of all was having the opportunity to view video footage of the nests. Some nests had been chosen as "camera nests" and motion-sensor video cameras were placed near the nests. These cameras enable researchers to observe the behavior of both the parents and any predators that may have eaten eggs.

Not only was it just fun to watch the birds roosting, but I also learned so much about nest predation. Avian predators, especially gulls, are notorious for catching the chicks—radios that had previously been put on chicks were often found in the local gull colony and even in owl pellets. However, weeks into the nesting season, we still had not seen any gull predation videos. Then, much to our surprise, we caught a Red-tail Hawk eating the eggs on video!

After that, we started to finally see gull predation. Other predators caught on video included ravens, skunks, foxes, and raccoons. So while I got to see common predations, I was also privileged to view some of the more uncommon predators.

BABY STEPS Terns migrated into the area after the stilts and avocets were already nesting, and the capturing, tagging, and nest-monitoring procedure was similar. Unlike avocets and stilts, terns nest in large colonies and this made tagging the chicks more challenging since hundreds of chicks were running around at once.

Each week, we recaptured, weighed and measured tern chicks, and a growth curve was assembled. The field season came to a close as these chicks matured and eventually fledged, and I went on my way to Ashland, Oregon to be closer to the nature that I love.

Working with experienced biologists was a huge learning opportunity. I heard many stories of past field experiences and whenever I had questions about our project or even a random biology-related question, I had a wealth of resources and people to learn from.

By Maliheh Nakhai. Mali was an intern for the Waterbird Program from March to August 2006.